TAXA COMPOSITION, ABUNDANCE, DISTRIBUTION AND DIVERSITY OF THE PLANKTONIC ORGANISMS OF RIVER OGUNPA, IBADAN, NIGERIA

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Abstract

The plankton of a polluted river in Ibadan city, Nigeria was studied during the early rainy season to assess spatial variation in taxa composition, abundance, distribution and diversity. Five sampling stations were established along the course of the river spanning a distance of about 10 kilometers. Forty-eight genera of plankton were recorded; nine of Cyanophyceae, thirteen each of Chlorophyceae and Bacillariophyceae, seven of Protozoa and three each of Rotifera and Crustacea. Members of Cyanophyceae dominated the assemblage accounting for 91.77% of the total plankton abundance. All the major plankton groups except Rotifera and Crustacea were represented at the five stations. Shannon-Wiener diversity index and evenness followed the same pattern for phytoplankton: Bacillariophyceae>Chlorophyceaea>Cyanophyceae. Shannon-Wiener diversity and evenness followed different patterns for zooplankton: Protozoa>Rotifera>Crustacea and Rotifera>Protozoa>Crustacea respectively. High relative abundance of Cyanophyceae and their presence either mostly in the colonial or filamentous form may be indicative of the influence of organic pollution on the plankton community of River Ogunpa.

Keywords: plankton, composition, abundance, distribution, diversity.

1. Introduction

River Ogunpa, which flows through Ibadan city, is used for the dumping of domestic and other raw sewage due to high population pressure, rapid urbanization (Odubela, 1995), and high rate of resource consumption (Kinako, 1979; and Ayoade, 1994). The polluted status of Ogunpa River is well documented (Ajayi and Adelaye, 1977; Mombeshora *et al.*, 1981; Mombeshora *et al.*, 1983; Sridhar and Bammeke, 1985; and Fagade *et al.*, 1993). Spatial variation in the pollution status of the river has been investigated (Atobatele, 2005). This is as a result of the large land area drained by the river (55km^2), and due to differences in the pollutants introduced into the water at various places within the river basin. Although Mombeshora *et al.*, (1981) and Fagade *et al.*, (1993) reported high levels of oxygen demanding organic pollution and low levels of heavy metal pollution, the levels of lead, cadmium and zinc may be increasing to dangerous levels (Atobatele, 2005). Plankton studies of Ogunpa River and Ona River in relation to environmental factors have been carried out by Oduwole (1997).

Plankton, particularly phytoplankton respond quickly to environmental changes because of their short life cycle. Consequently phytoplanktons are used as indicators of water quality. Therefore, freshwater ecosystems inhabited by planktonic organisms suit the investigation of the factors influencing the composition, abundance, distribution and diversity of species [APHA, 1992].

Most of the work already carried out on Ogunpa River is on physico-chemical and heavy metal parameters. This paper therefore aims to determine spatial variation in the taxa composition, abundance and diversity of planktonic organisms in Ogunpa River.

Materials and Methods

(a) Study Area

River Ogunpa is enclosed between longitude 3°50'E to 4°00'E and latitude 7°15'N to 7°25'N and flows through the city of Ibadan mostly in a North-South direction (Figure 1). The river has several tributaries and flows over a stretch of about 20km from its source (Ashi) before it joins River Ona (Figure. 1). The area is underlain by old metamorphic rocks [Udo, 1994].

Station 1 is located 2.5km from source. The river at this point drains residential areas. The main activity around this station is car-wash service.

Station 2 is located about 4.8km from source. The river at this point drains the Agodi fish pond, University College Hospital (UCH) and residential areas. The major activities at this station include swimming, bathing and washing.

Station 3 is about 7.4km from source. It is a commercial area (with traffic congestion) and drains the heart of the city. The river at this point is contaminated with human faeces and solid wastes.

Station 4 is about 10.3km from source. The river at the point drains its largest tributary, the Kudeti River.

Station 5 is about 12.5km from source. It also drains residential areas.

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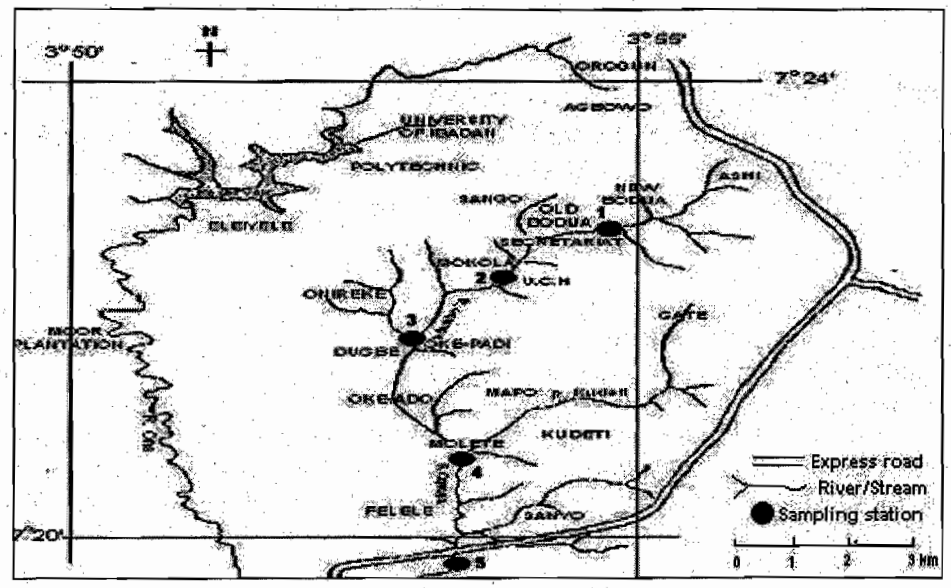

Figure 1: Map of Ibadan showing River Ogunpa and Sampling Stations.

Fortnightly sampling was undertaken at the five selected study stations from May to July 2000. Sampling was carried out between 0800h and 1230h on each sampling day. Plankton samples were collected with plankton net (No. 10, mesh size 109 (mm). The mouth of the plankton net was submerged below the surface of the river for 10 minutes facing the direction of flow. Samples were preserved in 5% buffered formalin. To account for differences in sample volume collected at the different stations the volume of river water filtered was determined using the formula,

$$volume\,(in\,liters) = \pi r^2 d$$

where d= current velocity x sampling time.
πr^2 = the area of the opening of plankton net.
In the laboratory, the preserved plankton sample was gently agitated and a 1ml subsample was withdrawn using a pipette, transferred to a Petri dish, stained with Lugol's iodine and examined under a compound microscope. This was done five times for each sample. Identification was done using plankton guides [APHA, 1992; Green, 1960; Needham and Needham, 1969; and Jeje and Fernando 1986]. The average number of individual organisms per ml of subsample was counted, expressed as number of individual per litre of river water by calculation and the final value was expressed as percentage abundance of total plankton. Every cell of a colonial or a filamentous phytoplankton was counted as one (Nwankwo, 1986 and APHA, 1992).
Quantitative indices were used to determine the relative abundance, diversity and equitability of the genera and major groups of plankton; Shannon-Wierner's, Equitability and Coefficient of Community Similarity were used [Pielou, 1969; Krebs, 1978; Brower and Zar, 1979].

3. Results

(a) Plankton Checklist, Abundance and Distribution
Table 1 summarizes the composition, relative abundance and distribution of major plankton groups in the study stations. A total of 48 plankton genera belonging to six major plankton groups (Cyanophyceae, Chlorophyceae, Bacillariophyceae, Protozoa, Rotifera and Crustacea) were recorded. The highest number of genera (32) was recorded from Station 2 while Station 5 had the lowest number (19). Cyanophyceae accounted for 91.77 % of the total plankton followed by Chlorophyceae (5.98 %), and Bacillariophyceae (2.11 %). The zooplankton groups (Protozoa, Rotifera, and Crustacea) altogether accounted for 0.14 % of the total plankton. All the plankton groups except Rotifera and Crustacea were represented at the five stations. Rotifers were found only at Stations 1 and 2 while Crustacea were recorded at Stations 1 and 4 only. Total plankton abundance along the stations showed Station 3 to be the least abundant.
Cyanophyceae was most abundant at Station 1 (35.03 %) and least abundant at Station 5(8.91 %). Chlorophyceae and Bacillariophyceae were least abundant at Station 3 (0.19 % and 0.24 % respectively). However, both phytoplankton groups showed an increase in abundance at Station 5. The spatial abundance of Bacillariophyceae and Protozoa followed similar patterns. The two taxa increased at Station 2, decreased gradually at Station 3 for Bacillariophyceae (0.24 %) and at station 4 for Protozoa (<0.01%). Both taxa then increased at Station 5 to 0.52 % and 0.03 % for Bacillariophyceae and Protozoa, respectively.

Table 1: The composition, percentage abundance and distribution of major plankton groups in the study stations along River Ogunpa.

PLANKTON GROUP	Station 1		Station 2		Station 3		Station 4		Station 5		All stations	
	No of genera	Abundance (%) (n=4)	No of genera	Abundance (%) (n=4)	No of genera	Abundance (%) (n=4)	No of genera	Abundance (%) (n=4)	No of genera	Abundance (%) (n=4)	No of genera	Abundance (%) (n=4)
CYANOPHYCEAE	5	35.03	5	22.63	6	10.44	7	14.76	7	8.91	9	91.77
CHLOROPHYCEAE	8	0.78	10	0.40	5	0.19	6	1.71	4	2.90	13	5.98
BACILLARIOPHYCEAE	9	0.35	9	0.64	7	0.24	5	0.35	5	0.52	13	2.11
PROTOZOA	1	0.03	6	0.05	3	0.02	1	+	3	0.03	7	0.13
ROTIFERA	1	+	2	+	-	-	-	-	-	-	3	+
CRUSTACEA	3	0.01	-	-	-	-	1	+	-	-	3	0.01
TOTAL	27	36.20	32	23.72	21	10.89	20	16.82	19	12.36	48	100

n = number of samples per station. + = present but < 0.01% of total plankton. - = absent

The relative plankton abundance for each station shows that Cyanophyceae dominated (35.03 %) at Station 1, followed by Chlorophyceae, Bacillariophyceae and the zooplankton with 0.78 %, 0.35 % and 0.04 % respectively. This pattern was followed at station 5, however, Chlorophyceae (2.90 %) and Bacillariophyceae (0.52 %) increased in abundance relative to Cyanophyceae (8.91 %).

The distribution of plankton genera in each major group varied from station to station (Table 2). Among the Cyanophyceae, only *Merismopedia, Microcystis, Oscillatoria* and *Spirulina* were found at all the stations. *Cladophora* and *Closterium* (Chlorophyceae), *Nitzchia* and *Navicula* (Bacillariophyceae) were recorded at all the stations.

(b) Plankton Diversity and Evenness.

The indices of general diversity (H), evenness (E) calculated for the five stations are shown in Tables 3 and 4. The Shannon-Wierner diversity index for total plankton was highest at Station 4 (0.7873) and lowest at station 1 (0.3022) while plankton was most equitably distributed at Station 4 (0.605). However, Shannon-Wierner diversity index and Equitability index increased from Station 1 to 4 and decreased at Station 5. Bacillariophyceae recorded the highest diversity (0.8715) and evenness (0.7820) of all the plankton groups in the river; this was followed by Chlorophyceae (0.7095 and 0.6369 respectively). Cyanophyceae recorded the lowest diversity (0.4780) and evenness (0.5009) among the phytoplankton taxa.

However, for zooplankton taxa, diversity and evenness followed different patterns. Protozoa recorded the highest diversity (0.6290), followed by Rotifera (0.4127) and by Crustacea (0.3271). Rotifera recorded the highest evenness (0.8650) followed by Protozoa (0.7440) and by Crustacea (0.6856).

Sorensen's Coefficient of Community Similarity index (Table 5) showed that Stations 2 and 3 were most similar (0.744) in plankton composition while Stations 2 and 4 were the least similar (0.462) in plankton composition. Six genera belonging to four taxa; *Polycystis* (blue-green algae), *Mougeotia* (green algae), *Cyclotella* and *Tabellaria* (diatoms) and *Phacus* and *Vorticella* (protozoans) were present at Stations 2 and 3 but absent at Station 4. however, four genera belonging to two taxa; *Anabaena, Aphanocapsa* and *Nostoc* (blue-green algae) and *Oedogonium* (green algae) were present at Station 4 but absent at Stations 2 and 3.

4. Discussion

The plankton community identified during the study period was dominated by phytoplankton. Phytoplankton constitutes the primary producers in aquatic ecosystems. The most abundant phytoplankton in the river during the study period was the Cyanophyceae (blue-green algae) constituting about 91.77% of the total plankton. Blue-green algae have also been reported to be abundant in Ogunpa River during the dry season (Oduwole, 1997). This supports a high nutrient enrichment of the water body (Adebisi, 1989; Biswas, 1992; and Ugwumba, and Ugwumba 1993). The high abundance (91.77 %), low diversity (0.4780) and low evenness (0.5000) of Cyanophyceae are all indicative of polluted waters. Bacillariophyceae had a near constant abundance along the

stations; it recorded the highest diversity and evenness. This indicates that physical, chemical and biological properties of the river at different stations have little or no effect on the diatoms. Bacillariophyceae have been reported to qualitatively dominate some water bodies (Egborge, 1970; 1979; Nwankwo, 1986; and Haslam, 1990),

Protozoa recorded the highest occurrence and abundance of all the zooplankton taxa. The high abundance of phytoplankton compared to zooplankton of River Ogunpa may be partly attributable to the time of the year (early rainy season), when phytoplankton quickly responds to nutrients brought in by run-off into the river and to the reduced predation by zooplankton. Phytoplankton responds quickly to environmental changes because of their short life cycle (APHA, 1992).

All the blue-green algae except *Spirulina* are either colonial or filamentous. More so all green algae, except *Ankistrodesmus* and *Protococcus* are filamentous. The coccoid colonial blue-green algae forms, *Microcystis* and *Merismopedia* and a filamentous form *Oscillatoria* were present at all the

Table 2: The distribution of the plankton genera at the five sampling stations along River Ogunpa.

		STATION				
	Taxa	1(%)	2 (%)	3 (%)	4 (%)	5 (%)
	CYANOPHYCEAE (Blue-green algae)					
1	*Anabaena*	-	-	-	12.67	0.25
2	*Aphanocapsa*	-	-	-	0.39	-
3	*Coelosphaerium*	-	-	3.70	-	-
4	*Merismopedia*	0.71	0.05	2.36	5.77	3.89
5	*Microcystis*	83.48	74.12	78.70	38.27	0.87
6	*Nostoc*	-	-	-	25.84	39.06
7	*Oscillatoria*	2.74	20.02	8.28	4.10	26.98
8	*Polycystis*	9.76	1.19	0.58	-	1.01
9	*Spirulina*	0.10	0.01	2.22	0.66	0.01
	CHLOROPHYCEAE (Green algae)					
1	*Ankistrodesmus*	0.06	-	0.29	0.93	-
2	*Cladophora*	0.29	1.05	0.90	4.91	0.78
3	*Closterium*	0.19	0.14	0.31	0.75	0.13
4	*Cosmarium*	0.09	0.04	-	-	-
5	*Desmidium*	-	0.03	-	-	-
6	*Microspora*	-	0.01	-	-	-
7	*Mougeotia*	-	0.15	0.21	-	-
8	*Oedogonium*	-	-	-	2.11	-
9	*Protococus*	0.14	0.13	-	1.43	-
10	*Scenedesmus*	0.12	0.09	-	0.03	-
11	*Spirogyra*	1.28	0.02	-	-	-
12	*Stigeoclonium*	-	-	-	-	22.49
13	*Ulothrix*	+	0.02	0.06	-	0.04
	BACILLARIOPHYCEAE (Diatoms)					
1	*Cocconeis*	0.06	0.13	-	0.93	1.01
2	*Coscinodiscus*	-	-	0.05	-	-
3	*Cyclotella*	0.06	0.22	0.48	-	-
4	*Diatoma*	+	0.09	-	-	-
5	*Gomphonema*	-	-	-	-	0.10
6	*Melosira*	-	1.37	-	0.37	-
7	*Navicula*	0.39	0.36	0.10	0.54	2.74
8	*Nitzchia*	0.06	0.01	+	0.06	0.09
9	*Stauroneis*	0.02	+	-	-	-
10	*Stephanodiscus*	0.09	0.40	-	-	-
11	*Surirella*	-	-	0.58	0.19	0.25
12	*Synedra*	+	-	0.86	-	-
13	*Tabellaria*	0.29	0.14	0.17	-	-
	PROTOZOA (Protozoans)					
1	*Actinophrys*	-	0.01	-	-	-
2	*Difflugia*	-	0.05	0.10	-	0.08
3	*Dinobryon*	-	0.01	-	-	-
4	*Phacus*	-	0.01	0.03	-	-
5	*Prorodon*	-	-	-	0.01	-
6	*Trachelomonas*	-	0.13	-	-	0.10
7	*Vorticella*	0.07	0.01	0.02	-	0.09
	ROTIFERA (Rotifers)					
1	*Brachionus*	+	-	-	-	-
2	*Kellicotia*	-	+	-	-	-
3	*Notholca*	-	+	-	-	-
	CRUSTACEA (Crustaceans)					
1	*Calanus*	+	-	-	-	-
2	*Chydorus*	+	-	-	-	-
3	*Cyclops*	0.01	-	-	0.01	-

+ = present but < 0.01% of total plankton in each stations; - = absent

Table 3: Shannon-Wierner's diversity index (H) of plankton groups from five sampling stations along River Ogunpa

PLANKTON GROUP	STATION					
	1	2	3	4	5	All stations
CYANOPHYCEAE	0.218	0.254	0.308	0.601	0.432	0.4780
CHLOROPHYCEAE	0.595	0.593	0.570	0.601	0.083	0.7095
BACILLARIOPHYCEAE	0.678	0.665	0.643	0.496	0.420	0.8715
PROTOZOA	0.000	0.547	0.397	0.000	0.476	0.6290
ROTIFERA	0.000	0.301	-	-	-	0.4127
CRUSTACEA	0.373	-	-	0.000	-	0.3271
TOTAL	0.3022	0.3686	0.4098	0.7873	0.6635	

Table 4: Equitability Index (J) of the different plankton groups from the five sampling stations along River Ogunpa

	EQUITABILITY					
PLANKTON GROUP	1	2	3	4	5	All stations
CYANOPHYCEAE	0.312	0.363	0.369	0.711	0.511	0.5009
CHLOROPHYCEAE	0.659	0.593	0.815	0.772	0.138	0.6369
BACILLARIOPHYCEAE	0.711	0.697	0.761	0.710	0.601	0.7820
PROTOZOA	0.000	0.703	0.832	0.000	0.998	0.7440
ROTIFERA	0.000	1.000	-	-	-	0.8650
CRUSTACEA	0.782	-	-	0.000	-	0.6856
TOTAL	0.2110	0.2450	0.3100	0.6050	0.5190	

Table 5: Coefficient of Community Similarity (CCs) between the five sampling stations along river Ogunpa

SAMPLING STATIONS	1	2	3	4	5
1					
2	0.712				
3	0.583	0.744			
4	0.511	0.462	0.488		
5	0.522	0.549	0.650	0.615	

sites. These blue-green algae genera are indicative of polluted waters [Egborge, 1979 and Nwankwo, 1986]. The presence of *Stigeoclonium*, a sewage fungus, only at Station 5 might be due to the effect of a reduced current velocity and partly to the rocky nature of the substratum at this station. *Stigeoclonium* has been reported as an example of algae growing on reservoir walls [APHA, 1992]. Presence of *Stigeoclonium* also indicates polluted water [Haslam, 1990].

Nitzchia and *Navicula* were recorded in all the stations; hence they are well distributed along the course of the river. Pennate diatoms were reported to be prevalent during the rainy season while the dry season diatoms were mostly centric forms [Nwankwo, 1986]. This might account for the low distribution of *Coscinodiscus*, which was recorded only at Station 3. Diversity of plankton and total plankton abundance were least at station 3 suggesting a more severe pollution at this station [Haslam, 1990].

Sorensen's Coefficient of Community Similarity shows Stations 2 and 3 to be the most similar (0.744) while Stations 2 and 4 (0.462) and Station 3 and 4 (0.488) were the least similar. Station 2 recorded the highest number of protozoan genera. The presence of the euglenoid genera, *Phacus*, at Stations 2 and 3 only suggests that they are the most polluted stations along River Ogunpa. Green euglenoids have been referred to as eutrophic species, and are abundant in locations rich in organic and inorganic matter (Kim and Boo, 2001). Higher percentages of abundance of *Microcystis* were also recorded at Stations 2 and 3 compared to Station 4. A species of the genus, *Microcystis aeruginosa*, has been implicated in bloom formation of freshwaters (Egborge, 1979; Nwankwo, 1986 and Opute, 1990). Consequently Stations 2 and 3 may be regarded as the most polluted while Station 4 may be regarded as the least polluted for the plankton of River Ogunpa during the study period.

The present state of the river can be improved by enforcing established water quality criteria, guidelines, specification or standard to protect the Ogunpa River from further degradation from various discharges into it. The Oyo State Ministry of Environment and Water Resources should undertake this task. This can be done by enforcing the control and treatment of sewage and other wastes before being discharged into the river and also by prohibiting solid waste and fecal discharge into the river.

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